

Nuts and Seeds Bioactive compounds and Related Nutraceutical Properties - A Review

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ABSTRACT:

Nuts and seeds are good sources of energy. Nuts and seeds are very nutritious, providing lipids and essential vitamins (vitamin A and E) and minerals (phosphorous and potassium). They contain substances of high nutritive values like proteins, minerals, carbohydrates and lipids and also possess phytochemical constituents (alkaloids, flavanoids and phenolic compounds). These compounds exhibited beneficial effects in prevention of disease. Nuts and seeds showed different degree of nutraceutical effects such as antioxidant, anticancer activity and also prevention of cardiovascular disease. In this article, the nutraceutical, phytochemicals constituents and their associated health functions of few nuts and seeds are reviewed.

Keywords: Nuts and seeds, Nutrition, Beneficial effects, Antioxidant

INTRODUCTION

Nuts are the important sources for both humans and animals due to their nutritional value. Consumption of nuts has been linked to a lowered risk of cardiovascular heart disease [1]. Hard shelled fruits of some plants that have an indehiscent seed are known as nuts. The women who consume nuts two to four times per week reduced risks of fatal cardiovascular heart disease [2]. In addition, more than 80,000 women who consume nuts about five times per week lowered their risk of heart disease by 35% and Type 2 diabetes by 27 % [3]. In the present article, we reviewed some particular nuts and seeds for their nutraceutical, phytochemicals constituents and their associated health functions.

Nutritional values of nuts: Nuts are good sources of nutrition and are rich in proteins, vitamins, minerals, dietary fibres, essential fatty acid.

Proteins: Nuts are one of the best sources of proteins as they are essential building blocks of the body, essential for growth, immune functions, enzymatic functions and transport functions. In addition, nuts are good alternative source of protein for vegetarians [4].

Fibres: Nuts are also great sources of fibres. Adequate fibre was essential for bowel health and reducing cholesterol levels [4].

Fats: Nuts are good sources of fats such as mono and polyunsaturated fats and saturated fats and they reduce the blood cholesterol level. Nut also contain omega 3 fatty acid a type of polyunsaturated fat and associated with reduction in blood clots leading to protection against heart disease and strokes [4].

Vitamins and Minerals: Nuts are excellent source of vitamins, (B, K, E) minerals like magnesium, iron, potassium, selenium and copper and they also have antioxidant property [4].

Beneficial constituents of nuts: Nuts improves the human health conditions due to their unique protein, fat, sterol, and vitamins.

Proteins in nuts:

Nuts contain arginine, an amino acid that reduces cholesterol level as a precursor to nitric oxide, dilates blood vessels, thus reducing the risk of angina, congestive heart failure and heart attacks [5].

Vitamins in nuts:

Vitamin E is an antioxidant which prevents the oxidation of cholesterol that leads to fatty build up in the arteries. Vitamin B folate lowers the high blood level of homocysteine, a strong predictor of heart disease [5].

Healthy phytochemicals constituents in nuts:

The coatings of all nuts are rich in polyphenols, an antioxidant associated with reduced risk of heart disease. Walnuts are rich sources of alpha linolenic acid that protect heart and blood circulation [5].

Other health benefits of nuts [6]:

1. Reducing symptoms of metabolic syndrome
2. Reducing the risk of gall stones
3. Maintaining bone health
4. Reducing age-related macular degeneration (which leads to blindness)
5. Slowing brain aging

NUTS IN HUMAN HEALTH:

Nuts has nutritional effects in prevention of coronary heart disease in diabetes and cancers.

1. Nuts in management of cardiovascular disease

Cardiovascular disease (CVD) rates are increasing in the developing countries. People with diabetes are likely to develop CVD. Eating small quantities of nuts has been shown to reduce the risk of CVD by 51% [7]. Nuts are found to be associated with reduced risk of heart disease in the Adventist Health Study (AHS). As per the study, the risk of coronary heart disease was lowered (37%) for those who consume nuts more than four times per week compared to those who never consume [8].

2. Nuts in management of cancer

There are very few studies indicating that, the relationship between nut consumption and risk of cancer prevention. Nuts prevents cancer due to their antioxidant activity, the regulation of cell differentiation and proliferation, repair of DNA damage, regulation of immunological and inflammatory responses, the reduction of tumor initiation or promotion and induction or inhibition of metabolic enzymes. Phytic acid is a plant natural antioxidant found in nuts and it reduced the rate of colon cancer and also inflammatory bowel diseases. Presence of beta sitosterol and campesterol in nuts suppresses the breast and prostate tumors [9].

TYPES OF NUTS AND ITS NUTRACEUTICAL POTENTIAL:

1. Brazil nut (*Bertholletia excels*: **Lecythidaceae**)
2. Cashew nut (*Anacardium occidentale*: **Anacardiaceae**)
3. Coconut (*Cocos nucifera*: **Arecaceae**)
4. Chest nut (*Castanea*: **Fagaceae**)
5. Ginkgo nut (*Ginkgo biloba*: **Ginkgoaceae**)
6. Hazel nut (*Corylus*: **Betulaceae**)
7. Kola nut (*Cola*: **Malvaceae**)
8. Peanuts (*Arachis hypogaea*: **Fabaceae**)
9. Walnut (*Juglans*: **Juglandaceae**)

1. Brazil nut (*Bertholletia excels*: **Lecythidaceae**)

Brazil nut is a giant tree of the Amazon rain forest of Brazil. It belongs to the Lecythis family and is closely related to a group of South American nut trees known as monkey pots. The trees tower 200 feet and their spreading branches and flowers provide habitat and food for numerous forest creatures [10]. Brazil nuts contain 2S albumin isoforms which had been characterized by circular dichorism and fourier transform- infra red spectroscopy and indicated that isoforms were α -helical in nature [11]. Several health benefits and epidemiological studies of Brazil nuts showed relationship between cardio vascular diseases and cancers. Brazil nut reduced the risk factors in the

development of cancer and atherosclerosis due to presences of flavonoids and phenolic constituents [12].

2. Cashew nut (*Anacardium occidentale*: **Anacardiaceae**)

Cashew is a small evergreen tree growing up to a height of 10 to 12 m tall. Cashew nuts are cultivated widely all over the world and are cultivated in North America, South America, Europe, India and northeastern parts of Brazil, in the area between Amazon forest and Atlantic rain forests [13]. Ethanol extracts of cashew nut skin powder exhibited antioxidant activity by radical scavenging assay [14].

3. Coconut (*Cocos nucifera*: **Arecaceae**)

It is a native to South Asia and South America. Coconut requires warm condition for successful growth and is intolerant of cold weather. Optimum growth is with a mean annual temperature of 27 °C and growth is reduced below 21°C. They may grow but do not produce proper fruit in areas where there is not sufficient warmth like Bermuda. Coconut flour is a rich source of dietary fiber [15]. In addition, dietary fiber from coconut flour reduced the serum total cholesterol, low density lipoprotein and triglycerides of humans with moderately raised serum cholesterol level [16]. Coconut water showed lipid lowering effects similar to the drug lovastatin in rats fed-cholesterol enriched diet [17].

4. Chest nut (*Castanea*: **Fagaceae**)

Chest nut is a genus of eight or nine species of deciduous trees and shrubs in the beech family Fagaceae, native to temperate regions of the northern hemisphere. Chest nut gives a better crop when subjected to chill temperatures during the dormant period. Frosts and snowfalls are beneficial rather than harmful to chest nut trees. It can be found at altitude between 200 and 1000 meters above sea level. While the famous chestnut tree of one hundred horses on Mount Etna stands at 1200m altitude [18].

Chest nuts have been increasingly used in human nutrition because of their nutrient contents and beneficial health activities. The lipid compositions of chest nuts were examined and reported that chest nuts contain 17% of saturated fatty acid and 83% of high unsaturated fatty acid [19]. A new pyrrole alkaloid, methyl-(5-formyl-1Hpyrrole-2-yl)-4-hydroxybutyrate was isolated from the chestnut seeds and its structure were elucidated based on the NMR spectroscopy [20].

The antioxidant activity of the chestnut of the ecotypes (Marrone di Castel del Rio, Marrone di Marradi, Marrone di Valle Castellana) of Italy were investigated. All the ecotypes showed polyphenol content which accounted for discrete antioxidant activity [21].

5. Ginkgo nut (*Ginkgo biloba*: Ginkgoaceae)

The tree currently occurs in the wild only in the North West of Zhejiang province in the Tianmu Shan mountain reserve in Eastern China. Because of its status in Buddhism and Confucianism, the Ginkgo is widely planted in Korea and parts of Japan; in both areas, some naturalization has occurred, with Ginkgos seeding into natural forests [22]. The lipid extracts of the ginkgo nuts was used as a therapeutic agent for cardiovascular disease. Lipid extracts of the ginkgo nuts were tested by *in vivo* mouse feeding model and results indicated that ginkgo nut modulates the serum cholesterol level by modulating the apolipoprotein secretion as well as low density lipoprotein receptor in the liver [23]. Ginkgo biloba nuts showed antioxidant activity due to their ability to scavenge 2,2'-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) free radicals. In addition, 60% of heat stable antioxidant components of seeds were available and 40% were lost during cooking [24].

6. Hazel nut (*Corylus*: Betulaceae)

Hazel nut is cultivated in Europe, Turkey, Iran and Caucasus. In India, they are cultivated in Pangi valley of Chamba district. The hazel nut is spherical in shape about 15 to 25 mm long and 10 to 15 mm diameter [25]. Hazel nut are rich in protein and unsaturated fats. Hazel nuts exhibited antioxidant activity due to presence of chemical constituents such lipid, minerals and protein. In addition, it showed antimicrobial activity against Gram positive (*Bacillus cereus*, *B.subtilis*, *Staphylococcus aureus*) and Gram negative (*Pseudomonas aeruginosa*, *E.coli*, *K.pneumoniae*) and fungi (*Candida albicans*, *Cryptococcus neoformans*) [26].

7. Kola nut (*Cola*: Malvaceae)

Kola nut is the Cola genus originated in Africa. All the species within the genus requires steady warm temperatures and high levels of humidity, year round. Besides growing in parts of Africa they have been transported to other parts of the globe by the humans. They have also been cultivated in warm and humid parts of the world such as America and Asia. Cola is evergreen; they keep their leaves all year round [27]. Methanolic extracts of Garcinia Kola seeds were subjected to *in vitro* antioxidant methods and the results indicated that Garcinia Kola seeds exhibited antioxidant potential due to presence of garcinia biflavonoids, garcinal and garcinoic acid [28]. Kola nut extract was used as a flavoring ingredient in food industries due to presence of two important components such as caffeine and theobromine. In addition, kola nut extract was used in the preparation of the cola beverages [29].

8. Peanut (*Arachis hypogaea*: Fabaceae)

Peanut is grown in Mexico, South America and Central America, China and India. The plant grow 30 to 50 cm tall. They grow best in light, sandy loamy soil, and an annual rainfall of 500 to 1,000 mm or equivalent irrigation of water [30]. Water soluble isolates from peanuts showed antioxidant activity due to presence of total aminoacids and total polyphenolic constituents [31].

9. Walnut (*Juglans*: Juglandaceae)

Walnuts are deciduous trees of 10-40 meters tall and they are widely cultivated on temperate zones. They are grown in southeast Europe, Japan, southeast of Canada, California and Argentina. Walnuts can tolerate drought conditions and they need large amount of light to grow [32]. Aqueous extract of the walnut showed antioxidant and antimicrobial activity due to the total phenolic content present in the walnut [33].

SEEDS

The small embryonic plant enclosed by a thin coat that contains stored food materials of plant is called a seed. Seeds contain a hypo lipidemic substance like omega 3 fatty acid, a potent anti oxidant like vitamin E, as a source of copper, zinc, iron and calcium. Traditional knowledge of plants is responsible for most of the medicine and food used in modern society. After beginning of agricultural practices 1,200 years ago, 7,000 wild plant species have been collected and cultivated, but we presently use 15 plant species to supply 90% of world food [34, 35].

TYPES OF SEEDS AND ITS NUTRACEUTICAL POTENTIAL

1. Ajmud seed (*Carum roxburghianum*: Apiaceae)
2. Anise seed (*Pimpinella anisum*: Apiaceae)
3. Bael seed (*Aegle marmelos*: Rutaceae)
4. *Benincasa hispida* seed (Winter melon seed)
5. Caraway seed (*Carum carvi*: Apiaceae)
6. Datura metel (*Datura metel*: Solanaceae)
7. Fennel seed (*Foeniculum vulgare*: Apiaceae)
8. Flax seed (*Linum usitatissimum*: Linaceae)
9. Jambul seed (*Syzygium cumini*: Myrtaceae)
10. Lotus seed (*Nelumbo nucifera*: Nelumbonaceae)
11. Moringa (*Moringa oleifera*: Moringaceae)
12. Mustard seed (*Brassica juncea*: Brassicaceae)
13. Nutmeg seed (*Myristica fragrans*: Myristicaceae)
14. Poppy seed (*Papaver somniferum*: Papaveraceae)
15. Sesame seed (*Sesamum indicum*: pedaliaceae)
16. Star Anise (*Illicium verum*: Illiciaceae)
17. Tamanu seed (*Calophyllum inophyllum*: Clusiaceae)

1. Ajmud seed (*Carum roxburghianum*: Apiaceae)

Seed of *C.roxburghianum* is a flowering plant and it is grown extensively on Southeast Asia and Indonesia. Seeds have aromatic properties. So it is used in the spice ajwin [36]. *C.roxburghianum* seed oil was used as

a flavouring agent and it showed antibacterial activity. In addition, oil has been used in the folk medicine in the treatment of hiccough, vomiting and pain in bladder [37].

2. Anise seed (*Pimpinella anisum*: Apiaceae)

Anise grows well in the fertile, well drained, good light source and it is native to the eastern Mediterranean region and Southwest Asia. As the ground warms up the seeds should be planted immediately. It was an herbaceous plant that grows for a height of 3 feet tall [38]. The ethanol and water extracts of the anise seeds exhibited antimicrobial activity by disc diffusion method and antioxidant activities by free radical scavenging and superoxide radical scavenging assay [39]. Hot water extracts of anise seeds widely used in medicines because of their anti diuretic, laxative effect and anti spasmodic action. Oils of anise seeds increased the glucose absorption and reduced the output of urine in the rat [40].

3. Bael seed (*Aegle marmelos*: Rutaceae)

It is indigenous to dry forests on hills and plains of central and southern India. *Aegle marmelos* grows up to 18 meters tall and bears thorns and fragrant flowers. It has a woody skinned, smooth fruit 5-15 cm in diameter. The tree grows on hills and plains of Central and Southern India, Burma, Pakistan and Bangladesh. It is a sub tropical species. In Punjab, it grows up to an altitude of 1,200m where the temperature raises up to 48.89°C in the shade in summer and descends to -6.67° C in the winter, and prolonged droughts occur [41]. *Aegle marmelos* Corr is widely used in Indian Ayurvedic medicine for the treatment of diabetes mellitus.

The aqueous extract of *Aegle marmelos* seeds was administered orally at different doses (100, 250, and 500mg/kg) to normal as well as sub (fasting blood glucose) normal and mild (FBG 120-250 mg/dl) diabetic rats. The results indicated that the aqueous extract of seed (250mg/kg) exhibited potent anti-diabetic and hypolipidemic effects in rats [42]. A two novel compounds (2-isopropenyl-4-methyl-1-oxa-cyclopenta[b]anthracene-5,10-dione and [+]-4-(2'-hydroxy-3'-methylbut3'enyloxy)8H-[1,3]-dioxol-o[4,5-h]chromen-8-one) from the seeds of *A.marmelos* Corr exhibiting anti-fungal activity against pathogenic strains of fungi such as *A.fumigatus*, *A.flavus*, *A.niger*, *C.parapsilosis*, *C.tropicalis*, *C.albicans*, *T.mentagrophytes*, *C.neoformans*, *S.schenckii*, *T.viride*, *M.gypseum*, *A.romosa*, *P.boydii*, *S.cerevisiae* [43]. A new anthraquinone (1-methyl-2-(3'-methyl-but-2'-enyloxy) has been isolated from seeds of *Aegle marmelos* Correa and new compound exhibited anti-fungal activity against *Aspergillus* species and *Candida albicans* by disc diffusion assay, microbroth dilution, and percent spore germination inhibition [44].

4. Benincasa hispida seed (Winter melon seed)

It is native to the South Asia and East Asia. Rind and seeds of gourd discovered at the Kana site in Papua New Guinea are identified as remains of *Benincasa hispida*. The origin and dispersal of this species were discussed with reference to bottle gourd, *Lagenaria siceraria* an another cucurbit that is wide spread in Asia and Pacific [45].

The methanolic extract of *Benincasa hispida* possesses antinociceptive and antipyretic activities. In addition, acute toxicity studies the ethanolic extract of the seeds was found to be safe and there was no mortality [46]. Seed extracts of *Benincasa hispida* was used to study the anti-angiogenic effect on the endothelial cells. Basic fibroblast growth factor (bFGF) is a potent angiogenic factor found in many tumors. The *Benincasa hispida* seed extracts inhibited the proliferation of endothelial cells induced by bFGF [47].

5. Caraway seed (*Carum carvi*: Apiaceae)

Caraway grows wild in Europe, North Africa and Asia. Caraway was cultivated in Russia and United states. The seeds are harvested ripe in late summer. They grows best in well-tilled, moderately lightly clay soil that is rich in humus. Caraway needs full sunlight and seeds are slow to germinate. Plant seeds about 6mm deep. Seedlings usually emerge within 8 to 12 days. Caraway seeds can also be grown well in the containers but several precautionary measures have to be taken while growing [48]. The methanol extract of cold pressed black caraway seed showed anti oxidant properties. In addition, caraway seed oil also used as a food additive for improving the food quality and stability [49].

6. Datura metel (*Datura metel*: Solanaceae)

It is found in India, England and other tropical regions. It grows in the wild in all the warmer parts of the world. It is cultivated worldwide for its chemical and ornamental properties [50]. The main chemical constituent of *Datura metel* contains total alkaloids. The seed powder of *Datura metel* showed hypoglycemic activity and anti-hyperglycemic activity in diabetic induced alloxan and normal rats [51].

7. Fennel seed (*Foeniculum vulgare*: Apiaceae)

It is cultivated in Romanian, Russia, Germany, France and India. In India, it is cultivated in Gujarat, Punjab, Rajasthan and West Bengal. Fennel consists of volatile oil, protein and fixed oil [52]. Aqueous extract of *Foeniculum vulgare* seed showed antioxidant capacities by various assays such as free radical scavenging, total antioxidant, superoxide anion radical scavenging, metal chelating and hydrogen peroxide scavenging [53].

8. Flax seed (*Linum usitatissimum*: Linaceae)

The major fibre flax producing countries are Canada, USA and China. The most suitable soils for flax are deep friable loams and containing a large proportion of organic matter. Flax was grown from seeds and they need rich soil to grow. Within six weeks of sowing, the plant will reach 10-15 cm in height, and will grow several centimeters per day under its optimal growth conditions, reaching 70-80 cm within fifteen days. Flax grown for seed is allowed to mature until the seed capsules are yellow and just starting to split; it is then harvested and dried to extract the seed [54].

Flax seeds are rich in omega-3 fatty acid and decreased the production of interleukin-1, tumor necrosis factor, oxygen free radicals by polymorphonuclear leukocytes (PMNL) and monocytes. They reduced the development of aortic atherosclerosis without lowering the serum cholesterol [55]. Flax seed and Pumpkin seeds are rich sources of unsaturated fatty acids and fibres and showed antioxidant, anti-atherogenic and hepatoprotective activities [56].

9. Jambul seed (*Syzygium cumini*: Myrtaceae)

Syzygium cumini is a native to the sub-tropical Himalayas, India, Sri Lanka, Malaysia and Australia, where it is also widely cultivated. In the Himalayan valleys, it ascends to about 1,200m and in the Nilgiris to 1,800m. It tolerates prolonged flooding and once established, it can tolerate drought. In dry sites, it generally confines itself to the vicinity of the water resources. It can grow on shallow, rocky soils provided the rainfall is sufficient [57].

Syzygium cumini seed kernel extracts showed alpha glucosidase inhibitory effects on mammalian α -glucosidase when compared to the acarbose control. In addition, *in vivo* studies also showed α -glucosidase inhibitory effects with acetone extract of *Syzygium cumini* seed [58]. The betulinic acid, 3,5, 7, 4- tetra hydroxyl flavanone compound was isolated from *Syzygium cumini* seed extracts and showed alpha amylase inhibitory effects against porcine pancreatic α -amylase [59]. Ethyl acetate and methanol extracts of *Syzygium cumini* seed exhibited anti inflammatory property in carageenan-induced paw oedema in wistar rats [60].

10. Lotus seed (*Nelumbo nucifera*: Nelumbonaceae)

Lotus was an aquatic plant and they are commonly found in Southern Asia and Australia. They are mostly cultivated in water gardens [61]. Lotus is the national flower of India and Vietnam. Hot water extracts of the lotus seeds showed antioxidant properties [62].

11. Moringa (*Moringa oleifera*: Moringaceae)

Moringa is a heat loving plant. It cannot tolerate freeze or frost. It can also be propagated by seed.

Seeds are planted an inch below the surface and can be germinated in well draining soil. *Moringa* is common in India and is particularly suitable for dry regions only. The tree can be even grown on land covered with 10-90 cm of mud. *Moringa* is grown in home gardens as living fences in Thailand, where it is commonly sold in local markets *Moringa* is also actively cultivated in Taiwan [63].

The aqueous extracts of *Moringa olifera* seed showed antimicrobial activity against bacterial stains such as *Escherichia coli*, *Bacillus subtilis*, *Pasturella multocida*, *Staphylococcus aureus* and fungal strains such as *Fusarium solani*, *Rhizopus solani* by minimal inhibitory concentration (MIC) and disc diffusion method [64].

12. Mustard seed (*Brassica juncea*: Brassicaceae)

Mustard grows well in temperate regions. Major producers of mustard seeds include Hungary, Great Britain, India, Pakistan, Canada (90%) and the United States. Brown and black seeds return higher yields than yellow counterparts. It is cultivated over an area of 307,000 hectares with an annual production of 233,000 tonnes and contributes about 17% to the domestic production of edible oil. Mustard seed is a rich source of oil as high as 46-48 % [65]. *Brassica juncea* seeds prevented the development of insulin resistance in rats with fructose enriched diet [66].

13. Nutmeg seed (*Myristica fragrans*: Myristicaceae)

It is native to the Banda Islands of Indonesia and Penang Island in Malaysia. It grows wild on rich volcanic soils in lowland tropical rain forests. Its cultivation as a crop is largely confined to islands in the hot, humid tropics at altitudes up to 4,500 meters [67]. The n-hexane extract of *Myristica fragrans* seeds showed angiogenic activity [68]. Seeds of *Myristica fragrans* exhibited chemopreventive action of mace (aril covering the testa of the seed) on 3-methylcholanthrene (MCA) induced carcinogenesis in the uterine cervix of virgin, young adult, Swiss Albino mice [69].

14. Poppy seed (*Papaver somniferum*: Papaveraceae)

It is native to China, India and Afghanistan. Poppy seeds are less than a millimeter in length and minute. It takes 3,300 poppy seeds to make up a gram and a pound contains between 1 and 2 million seeds. An annual, reaching 30-120cm (1-4ft), the lobed leaves have blue ting. The flowers are white to purple they grow up to 12cm (5in) in diameter [70]. Poppy seed reduced heart attack due to presence of linoleic acid. The oleic acid in the poppy seed oil was used in treatment of breast cancer. Poppy seed exhibited the anti carcinogenic activity in carcinoma-induced Swiss-mice [71]. In addition, aqueous extract of poppy seed

showed anti bacterial potential by disc diffusion method [72].

15. Sesame seed (*Sesamum indicum*: pedaliaceae)

Sesame are grown in many parts of the world the major producers from India, China, Myanmar, Sudan, Ethiopia, Uganda and Nigeria [73]. Ligan glycosides obtained by chromatographic separation from the unroasted sesame seeds exhibited antioxidant properties [74].

16. Star Anise (*Illicium verum*: Illiciaceae)

Star anise is a small fruit of an evergreen tree present in the Southwest China. They grow up to a height of 8m. They were widely cultivated on China, Japan for commercial uses. Star anise is used as spices in most of the food preparations in India and Andhra Pradesh [75]. Ethanol, water, and petroleum ether extracts from the star anise and caraway seeds showed antioxidant properties [76].

17. Tamanu seed (*Calophyllum inophyllum*: Clusiaceae)

Calophyllum inophyllum is a large evergreen. It is native from East Africa, Southern coastal India to Malaysia and Australia. Nowadays it is widely cultivated in all tropical regions of the world, including several Pacific Islands. It is a low branching and slow growing tree with a broad and irregular crown. It usually reaches 8 to 20 meters in height. The fruit is a round, green drupe reaching 2 to 4 centimeters in diameter and having a large seed. Because of its decorative leaves, fragrant flowers and spreading crown, it is best known as an ornamental plant. This grows in coastal regions as well as nearby lowland forests. But it is also been cultivated successfully in inland areas at moderate altitudes. It tolerates varied kinds of soil, coastal sand, clay or even degraded soil [77]. The oil extracted from tamanu seeds were used for the treatment of rheumatism, itch and wound healing [78].

CONCLUSION

Nuts and seeds have been found to be rich sources of fatty acids, proteins, fibre, vitamins and phytochemical compounds. The nuts and seeds can be useful in prevention of cancer and cardiovascular diseases due to presence of valuable antioxidant compounds. The phytochemical compounds present in the nuts and seeds exhibited the potential antioxidant, anticancer, diuretic and antispasmodic action. It is proposed that the nutrients in the nuts and seeds showed appreciable health benefits. Therefore, plant-based foods including nuts and seeds has important role in management of various diseases particularly cardiovascular disease and cancer. The present review summarizes the types, compositions, phytochemical compounds and their associated health benefits in the nuts and seeds.

Nonetheless, there is still an absence of information on the phytochemical compounds present in the nuts and seeds. Although several biological activities of phytochemical compounds have been identified in nuts and seeds, many more remain unidentified. Further research is necessary to identify the phytochemical compounds present in the nuts and seeds for their nutraceutical applications.

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